

Please delete the three full paragraphs on page 2 of the specification in favor of the following new paragraphs:

-- Although the Acheson method produces inexpensive, large quantities of silicon carbide, the precipitating silicon carbide is amorphous, comprising crystalline polymorphism and large quantities of impurities. In particular, this method cannot be employed to manufacture semiconductor materials in which defects and impurities are problematic.

The improved Lely method reduces the problems of crystalline polymorphism, amorphism, and the like associated with the Acheson method. However, it is difficult to reduce the impurities incorporated into the crystal, and increasing the area of the crystal and decreasing the number of defects are no simple tasks.

The method that is generally employed to reduce the crystal defects and impurities that are problematic in the improved Lely method is to use CVD or ALE to epitaxially grow silicon carbide while reducing the defect density and impurities on a silicon carbide substrate obtained by the improved Lely method. However, since the area of the crystals obtained by these methods is limited to the area of the silicon carbide obtained by the improved Lely method, large-area, high quality silicon carbide cannot be obtained. --

Please delete the paragraph bridging pages 2 and 3 in favor of the following new paragraph:

--To increase the area of silicon carbide, the general method has been devised of using CVD of ALE to heteroepitaxially grow a silicon carbide layer on a single crystal silicon substrate employed as a semiconductor material. However, high concentrations of defects are produced at the interface of the silicon substrate and the silicon carbide. Thus, the quality of the crystal is poorer than that of epitaxially grown silicon carbide layers formed on silicon carbide substrates obtained by the improved Lely method. When employing heteroepitaxial growth, crystal quality

can be improved by increasing the thickness of the film of silicon carbide being grown. However, since the rate of silicon carbide growth by CVD of ALE is extremely low, the application of silicon carbide obtained by heteroepitaxial growth is currently impeded. --

Please delete the paragraph of page 4, lines 13-24 of the text in favor of the following new paragraph:

-- the partial pressure  $p_s$  of said silicon source gas in said atmosphere is constant (with  $p_s > 0$ ), the partial pressure of said carbon source gas in said atmosphere consists of a state of  $p_{c1}$  and a state  $p_{c2}$

(where  $p_{c1}$  and  $p_{c2}$  denote partial pressures of said carbon source gas,  $p_{c1} > p_{c2}$ , and the partial pressure ratio ( $p_{c1}/p_s$ ) falls within a range of 1-10 times the sticking coefficient ratio ( $S_c/S_c$ ), the partial pressure ratio ( $p_{c2}/p_s$ ) falls within a range of less than one time the sticking coefficient ratio ( $S_c/S_c$ ))

(where  $S_c$  denotes the sticking coefficient of silicon source gas to the silicon carbide substrate at the substrate temperature during formation of said silicon carbide, and  $S_c$  denotes the sticking coefficient of carbon source gas to the silicon carbide substrate at the substrate temperature during the forming of said silicon carbide))--

Please delete the paragraph of page 5, lines 1-12 of the text in favor of the following new paragraph:

-- the partial pressure  $p_s$  of said silicon source gas in said atmosphere is constant (with  $p_s > 0$ ), the partial pressure of said carbon source gas in said atmosphere consists of a state of  $p_{c1}$  and a state  $p_{c2}$

(where  $p_{s1}$  and  $p_{s2}$  denote partial pressures of said silicon source gas,  $p_{s1} > p_{s2}$ , and the partial pressure ratio ( $p_c/p_{s1}$ ) falls within a range of 1-10 times the sticking coefficient ratio

( $S_c/S_c$ ), the partial pressure ratio ( $p_c/p_{s2}$ ) falls within a range of less than one time the sticking coefficient ratio ( $S_c/S_c$ )

(where  $S_c$  denotes the sticking coefficient of silicon source gas to the silicon carbide substrate at the substrate temperature during formation of said silicon carbide, and  $S_c$  denotes the sticking coefficient of carbon source gas to the silicon carbide substrate at the substrate temperature during the forming of said silicon carbide))--

Please delete the first two paragraphs of page 6 in favor of the following two new paragraphs:

-- The present invention further relates to a method of manufacturing silicon carbide characterized in that the silicon carbide manufactured in any of Claims 1-6 is employed as seed crystal and in that silicon carbide is formed on said seed crystal by vapor phase epitaxy, sublimation recrystallization, or liquid phase epitaxy.

In the above manufacturing method of silicon carbide, the preferred is that silicon carbide blocks 4-6 inches are formed by vapor phase epitaxy, sublimation recrystallization, or liquid phase epitaxy. --

Please delete the first paragraph of page 9 in favor of the following new paragraph:

-- Further, in condition 1, the partial pressure ratio ( $p_{c1}/p_s$ ) is set to within a range of 1-10 times the sticking coefficient ratio ( $S_c/S_c$ ) and the partial pressure gas ratio ( $p_{c2}/p_s$ ) is set to within a range of less than one time the sticking coefficient ratio ( $S_c/S_c$ ). Thus, during time  $t_{c2}$  when the partial pressure of the carbon source gas is  $p_{c2}$ , silicon carbide and Si precipitate simultaneously, and subsequently, during time  $t_{c1}$  when the partial pressure of the carbon source gas is  $p_{c1}$ , the precipitation of silicon carbide and the formation of silicon carbide through the reaction of precipitated Si and C occur simultaneously. The sticking coefficient ratio ( $S_c/S_c$ ) can

be calculated by a method described further below. --

Please delete the first paragraph of page 10 in favor of the following new paragraph:

-- Further, in condition 2, partial pressure ratio ( $p_c/p_{s1}$ ) is set to within a range of 1-10 times the sticking coefficient ratio ( $S_c/S_s$ ), and partial pressure ratio ( $p_c/p_{s2}$ ) is set to within a range of less than one time the sticking coefficient ratio ( $S_c/S_s$ ). Thus, during time  $t_{s2}$  when the partial pressure of the silicon source gas is  $p_{s2}$ , precipitation of silicon carbide and Si occurs precipitate simultaneously, and subsequently, during time  $t_{s1}$  when the partial pressure of the silicon source gas is  $p_{s1}$ , precipitation of silicon carbide and the formation of silicon carbide through the reaction of precipitated Si and C occur simultaneously. --

Please delete the second paragraph of page 10 in favor of the following new paragraph:

-- Sticking coefficient ratio ( $S_c/S_s$ ) can be determined in the following manner. --

Please delete the paragraph bridging pages 10 and 11 in favor of the following new paragraph:

-- Let  $\tau$  denote the time coordinates of the point of intersection of the tangent of  $n(t)$  when  $t=0$  and the asymptotic line when  $\tau \rightarrow \infty$ . Let  $\tau_c$  (the average residence time of the carbon source gas on the surface of the substrate) denote  $\tau$  when the gas employed is the carbon source gas. Let  $\tau_s$  (the average residence time of the silicon source gas on the surface of the substrate) denote  $\tau$  when the gas employed is the silicon source gas. The sticking coefficient ratio can then be calculated from the relation  $S_c/S_s = \tau_c / \tau_s$ . --

Please delete the first full paragraph of pages 11 in favor of the following new paragraph:

-- During the formation of silicon carbide by the manufacturing method of the present invention, setting the substrate temperature to not less than 900°C promotes the decomposition of molecules adhering to the substrate surface and promotes the reaction, and is suitable from the viewpoint of making it possible to establish a prescribed relation (the relation specified by

condition 1 and condition 2) between the partial pressure ratio and the sticking coefficient ratio that is independent of the types of gas. The substrate temperature desirable falls with a range of 1,100-1,370°C.--

Please delete the paragraph bridging pages 11 and 12 in favor of the following new paragraph:

-- As shown by Fig. 3 (1), when a silicon source is continuously fed to the substrate surface ( $p_s = \text{constant}$ ,  $p_{c2} = 0$ ), the silicon source thermally decomposes, for example, on the surface of the substrate that has been heated to not less than 900°C and a single crystal of silicon forms on the substrate surface (Fig. 3(2)). Here, when the carbon source is temporarily supplied (at  $p_{c2}$ ), the formation of the silicon layer on the substrate surface is inhibited and the silicon layer that formed on the substrate surface prior to the introduction of the carbon source simultaneously reacts with the carbon source, forming silicon carbide (Fig. 3(3)). In this process, when the partial pressure of the carbon source has been set to  $p_{c2}$ , the sticking coefficient of the carbon source to  $S_c$ , the partial pressure of the silicon source to  $p_s$ , and the sticking coefficient of the silicon source to  $S_s$ , and when  $p_{c2}$  or  $p_s$  is controlled to maintain a relation where  $p_{c2}/p_s$  during the carbon source supply is not less than one time and not more than ten times  $S_s/S_c$ , the incorporation of the silicon source onto the substrate surface is inhibited during feeding of the carbon source (Fig. 3(4)). --

Please delete the second and third full paragraphs of page 13 in favor of the following new paragraphs:

-- The present invention covers methods of manufacturing silicon carbide characterized in that silicon carbide manufactured by the above-described manufacturing method of the present invention, particularly thin film silicon carbide, is employed as seed crystal, and silicon carbide is formed on this seed crystal by vapor phase epitaxy, sublimation recrystallization, or liquid

phase epitaxy.

Vapor phase epitaxy, sublimation recrystallization, and liquid phase epitaxy methods for forming silicon carbide are as follows.--

Please delete the third paragraph of page 14 in favor of the following new paragraph:

-- Silicon carbide blocks (for example, ingots and structural members) with bores of from 4-6 inches (ranging from 100-160 mm) can be formed by the above-described manufacturing methods (vapor phase epitaxy, sublimation recrystallization, and liquid phase epitaxy). Here, the term "bore" corresponds to the diameter of the substrate employed in the above-described manufacturing methods. In conventional silicon carbide blocks, the bore runs up to about three inches, but based on the manufacturing method of the present invention, silicon carbide blocks with bores of 4-6 inches (equivalent to 102-152 mm, ranging from 100-160 mm) can be obtained. Further, the blocks obtained have planar defect densities of not more than  $10^3/\text{cm}^2$ . --

Please delete the first paragraph of page 16 in favor of the following new paragraph:

--Employing the  $\{101\}$  plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of  $1,200^\circ\text{C}$ , and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$ . The ratio  $S_s/S_c$  of the sticking coefficients of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$  on the surface of the silicon carbide was 0.25.--

Please delete the paragraph bridging pages 16 and 17 in favor of the following new paragraph:

-- Employing the  $\{001\}$  plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of  $1,200^\circ\text{C}$ , and 3C-silicon carbide

was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$ . The ratio  $S_s/S_c$  of the sticking coefficients of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$  on the surface of the silicon carbide was 0.25. --

Please delete the first paragraph of page 18 in favor of the following new paragraph:

-- Although  $\text{C}_2\text{H}_2$  was employed as the carbon source and  $\text{SiH}_2\text{Cl}_2$  as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than once and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of  $\text{CH}_4$ ,  $\text{C}_3\text{H}_8$ ,  $\text{C}_2\text{H}_6$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_3\text{H}_6$ ,  $\text{CCl}_4$ ,  $\text{CHF}_3$  and  $\text{CF}_4$  can be employed as the carbon source, and at least one member selected from the group consisting of  $\text{SiH}_4$ ,  $\text{Si}_2\text{H}_6$ ,  $\text{SiCl}_4$ ,  $\text{SiHCl}_3$ ,  $\text{Si}(\text{CH}_3)_4$ ,  $\text{SiH}_2(\text{CH}_3)_2$ ,  $\text{SiH}(\text{CH}_3)_3$  and  $\text{Si}_2(\text{CH}_3)_6$  can be employed as the silicon source to achieve the effect of the present invention.--

Please delete the second paragraph of page 18 in favor of the following new paragraph:

-- Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of  $1,200^\circ\text{C}$ , and 3C-silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$ . The ratio  $S_s/S_c$  of the sticking coefficients of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$  on the surface of the silicon carbide was 0.25.--

Please delete the first full paragraph of page 21 in favor of the following new paragraph:

-- Although  $\text{C}_2\text{H}_2$  was employed as the carbon source and  $\text{SiH}_2\text{Cl}_2$  as the silicon source

in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than once and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of  $\text{CH}_4$ ,  $\text{C}_3\text{H}_8$ ,  $\text{C}_2\text{H}_6$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_3\text{H}_6$ ,  $\text{CCl}_4$ ,  $\text{CHF}_3$  and  $\text{CF}_4$  can be employed as the carbon source, and at least one member selected from the group consisting of  $\text{SiH}_4$ ,  $\text{Si}_2\text{H}_6$ ,  $\text{SiCl}_4$ ,  $\text{SiHCl}_3$ ,  $\text{Si}(\text{CH}_3)_4$ ,  $\text{SiH}_2(\text{CH}_3)_2$ ,  $\text{SiH}(\text{CH}_3)_3$  and  $\text{Si}_2(\text{CH}_3)_6$  can be employed as the silicon source to achieve the effect of the present invention.--

Please delete the last two paragraphs of page 21 in favor of the following two new paragraphs:

-- Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of  $1,300^\circ\text{C}$ , and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of  $\text{H}_2$  to a pressure of 60 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of  $\text{SiCl}_4$  and  $\text{C}_3\text{H}_6$ . The ratio  $S_s/S_c$  of the attachment coefficients of  $\text{SiCl}_4$  and  $\text{C}_3\text{H}_6$  on the surface of the silicon carbide was 0.68.

The embodiment of the present invention will be described based on Fig. 7 below. While continuously feeding  $\text{SiCl}_4$  at a flow rate of 20 sccm,  $\text{C}_3\text{H}_6$  was intermittently fed to grow silicon carbide.  $\text{C}_3\text{H}_6$  was fed 1,000 times at intervals of 5 sec, each time lasting 5 sec. However, the flow rate  $fc$  of  $\text{C}_3\text{H}_6$  as treated as a parameter and  $fc_2$  was varied from 0.5-200 sccm and the change in silicon carbide growth rate was observed ( $fc_1=0$ , that is,  $pct=0$ ). --

Please delete the first full paragraph of page 24 in favor of the following new paragraph:

--Although [ $\text{C}_2\text{H}_5$ ]  $\text{C}_3\text{H}_6$  was employed as the carbon source and  $\text{SiCl}_4$  as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the



carbon source to the silicon source is not less than one time and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of  $\text{CH}_4$ ,  $\text{C}_3\text{H}_8$ ,  $\text{C}_2\text{H}_2$ ,  $\text{C}_2\text{H}_6$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_3\text{H}_6$ ,  $\text{CCl}_4$ ,  $\text{CHF}_3$ , and  $\text{CF}_4$  can be employed as the carbon source, and at least one member selected from the group consisting of  $\text{SiH}_4$ ,  $\text{SiH}_6$ ,  $\text{SiHCl}$ ,  $\text{SiHCl}_2$ ,  $\text{SiHCl}_3$ ,  $\text{Si}(\text{CH}_3)_4$ ,  $\text{SiH}_2(\text{CH}_3)_2$ ,  $\text{SiH}(\text{CH}_3)_3$ , and  $\text{Si}_2(\text{CH}_3)_6$  can be employed as the silicon source to achieve the effect of the present invention.--

Please delete the second full paragraph of page 24 in favor of the following new paragraph:

--Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of  $1,200^\circ\text{C}$ , and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$ . The ratio  $S_s/S_c$  of the sticking coefficients of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$  on the surface of the silicon carbide was 0.25.--

Please delete the first and second full paragraph of page 27 in favor of the following new paragraphs:

-- Although  $\text{C}_2\text{H}_2$  was employed as the carbon source and  $\text{SiH}_2\text{Cl}_2$  as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than one time and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of  $\text{CH}_4$ ,  $\text{C}_3\text{H}_8$ ,  $\text{C}_2\text{H}_6$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_3\text{H}_6$ ,  $\text{CCl}_4$ ,  $\text{CHF}_3$ , and  $\text{CF}_4$  can be employed as the carbon source, and at least one member selected from the group consisting of  $\text{SiH}_4$ ,  $\text{Si}_2\text{H}_6$ ,  $\text{SiCl}_4$ ,  $\text{SiHCl}_3$ ,  $\text{Si}(\text{CH}_3)_4$ ,  $\text{SiH}_2(\text{CH}_3)_2$ ,  $\text{SiH}(\text{CH}_3)_3$ , and  $\text{Si}_2(\text{CH}_3)_6$  can be employed as the silicon source to achieve the effect of the

present invention.

Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of 1,200°C, and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$ . The ratio  $S_s/S_c$  of the sticking coefficients of  $\text{SiH}_2\text{Cl}_2$  and  $\text{C}_2\text{H}_2$  on the surface of the silicon carbide was 0.25. --

Please delete the paragraph bridging pages 29 and 30 in favor of the following new paragraphs:

--Although  $\text{C}_2\text{H}_2$  was employed as the carbon source and  $\text{SiH}_2\text{Cl}_2$  as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than one time and not more than ten times the sticking coefficient ratio, at least one member selected from the group consisting of  $\text{CH}_4$ ,  $\text{C}_3\text{H}_8$ ,  $\text{C}_2\text{H}_6$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_3\text{H}_6$ ,  $\text{CCl}_4$ ,  $\text{CHF}_3$ , and  $\text{CF}_4$  can be employed as the carbon source, and at least one member selected from the group consisting of  $\text{SiH}_4$ ,  $\text{Si}_2\text{H}_6$ ,  $\text{SiCl}_4$ ,  $\text{SiHCl}_3$ ,  $\text{Si}(\text{CH}_3)_4$ ,  $\text{SiH}_2(\text{CH}_3)_2$ ,  $\text{SiH}(\text{CH}_3)_3$ , and  $\text{Si}_2(\text{CH}_3)_6$  can be employed as the silicon source to achieve the effect of the present invention.--

Please delete the third full paragraph of page 30 in favor of the following new paragraph:

--In addition to the above-described vapor phase epitaxy, other methods such as sublimation recrystallization and liquid phase epitaxy can be employed to form silicon carbide on seed crystal.--